CLAIMS

What is claimed is:

1. An image processing circuit that generates a plurality of color values each representing color components of a pixel of a digital image, the circuit comprising:

a register array that is organized in a plurality of lines of registers and that represents a portion of an array of pixels of the digital image;

a plurality of shift registers, in which each of the shift registers is coupled to receive an input from one of the lines of registers and to shift said input to another one an input from one of the lines of registers and to shift said input to another one of the lines of registers;

a plurality of directed linear product modules, each coupled to the register array, each of which generates an interpolated color value based on the register array; and

an interpolator module configured to receive image data values stored in the register array into the directed linear product modules, select at least one of the directed linear product modules for use in generating one of the color values, and generate the color values based on at least a result of the selected directed linear product module.

2. An image processing circuit that generates a plurality of color values each representing color components of a pixel of a digital image, the circuit comprising:

a register array that is organized in a plurality of lines of registers and that represents a portion of an array of pixels of the digital image;

a plurality of shift registers, in which each of the shift registers is coupled to receive an input from one of the lines of registers and to shift said input to another one an input from one of the lines of registers and to shift said input to another one of the lines of registers;

a plurality of dot product modules, each coupled to the register array, each of which generates an interpolated color value based on the register array;

a plurality of directed linear product modules, each coupled to the register array, each of which generates an interpolated color value based on the register array;

an edge detection module coupled to the register array and which generates at least one gradient value based on the register array; and

an interpolator module configured to

receive the at least one gradient value,

determine if the at least one gradient value exceeds a threshold value,

if the at least one gradient value exceeds the threshold value, then receive image data values stored in the register array into the directed linear product modules, select at least one of the directed linear product modules for use in generating one of the color values, and generate the color values based on at least a result of the selected directed linear product module, and

if the at least one gradient value does not exceed the threshold value, then receive image data values stored in the register array into the dot product modules, select at least one of the dot product modules for use in generating one of the color values, and generate the color values based on at least a result of the selected dot product module.

3. An image processing circuit that generates a plurality of color values each representing color components of a pixel of a digital image, the circuit comprising:

a register array that represents a portion of an array of pixels of the digital image;

a plurality of directed linear product modules, each coupled to the register array, each of which generates an interpolated color value at a target pixel based on the register array;

an edge detection module coupled to the register array and which generates a gradient value based on the register array; and

an interpolator module configured to

receive the gradient value,

determine if the gradient value exceeds a threshold value, and

if the gradient value exceeds the threshold value, then receive image data values stored in the register array into the directed linear product modules, select at least one of the directed linear product modules for use in generating one of the color values, and generate the color values based on at least a result of the selected directed linear product module.

4. The image processing circuit of claim 3, wherein:

the image processing circuit further comprises a plurality of dot product modules, each coupled to the register array, each of which generates an interpolated color value based on the register array;

the interpolator module is further configured to receive image data values stored in the register array into the dot product modules, select at least one of the dot product modules for use in generating one of the color values, and generate the color values based on at least a result of the selected dot product module, if it is determined that the gradient value does not exceed the threshold value.

5. The image processing circuit of claim 3, each module of the plurality of directed linear product modules further configured to use image data values from a subset of the register array in a vicinity of the target pixel.

6. The image processing circuit of claim 5, a particular module of the plurality of directed linear product modules further configured to discard a greatest value and a least value of the image data values for one color.

7. The image processing circuit of claim 5, a particular module of the plurality of directed linear product modules further configured to average a first value and a second

value of the image data values for one color, wherein the first value and the second value are no farther apart than any other pair of values for the one color in the subset of the register array.

8. The image processing circuit of claim 5, a particular module of the plurality of directed linear product modules further configured to discard a value of the image data for one color at a certain pixel, if an edge detected by the edge detector module lies between the certain pixel and the target pixel.

9. The image processing circuit of claim 3, the edge detection module further configured to compute an absolute value of a difference between a first value of the image data values for one color and a second value of the image data values for the same color, wherein the first value is at a first pixel located in a corner of the register array and the second value is at a second pixel located in an opposite corner of the register array.

10. The image processing circuit of claim 3, the edge detection module further configured to compute an absolute value of a difference between a first value of the image data values for one color and a second value of the image data values for the same color, wherein the first value is at a first pixel located toward a first end of a column of the register array, the column containing the target pixel, and the second value is at a second pixel located toward an opposite end of the column.

11. The image processing circuit of claim 3, the edge detection module further configured to compute an absolute value of a difference between a first value of the image data values for one color and a second value of the image data values for the same color, wherein the first value is at a first pixel located toward a first end of a row of the register array containing the target pixel, and the second value is at a second pixel located toward an opposite end of the row.

12. The image processing circuit of claim 3, wherein the threshold is selected in a range from about 5 % of a peak pixel value to about 40% of the peak pixel value.

13. The image processing circuit of claim 3, wherein the threshold is selected in a range from about 10 % of a peak pixel value to about 20% of the peak pixel value.

14. The image processing circuit of claim 3, wherein the image processing circuit further comprises an auto-focus module which provides a sum of absolute values of a first difference and a second difference, the first difference between a first value of the image data values and a second value of the image data values, and the second difference between a third value of the image data values and a fourth value of the image data values; the edge detection module is coupled to the auto-focus circuit; and the threshold is selected in a range from about 10 % of a peak pixel value to about 80% of the peak pixel value.

15. The image processing circuit of claim 3, the edge detection module further configured to compute an absolute value of a difference between a first value of the image data values for one color and a second value of the image data values for the same color, wherein the first value is at a first pixel located in a corner of a subset of the register array in a vicinity of the target pixel, and the second value is at a second pixel located in an opposite corner of the subset of the register array.

16. The image processing circuit of claim 3, the edge detection module further configured to compute an absolute value of a difference between a first value of the image data values for one color and a second value of the image data values for the same color, wherein the first value is at a first pixel located toward a first end of a column in a subset of the register array in a vicinity of the target pixel, the column containing the target pixel, and the second value is at a second pixel located toward an opposite end of the column.

17. The image processing circuit of claim 3, the edge detection module further configured to compute an absolute value of a difference between a first value of the image data values for one color and a second value of the image data values for the same color, wherein the first value is at a first pixel located toward a first end of a row in a subset of the register array, the row containing the target pixel, and the second value is at a second pixel located toward an opposite end of the row.

18. The image processing circuit of claim 3, the edge detection module further configured to

compute a long scale absolute value of a difference between a first value of the image data values in a first row or column of the register array and a second value of the image data values in a last row or column of the register array;

compute a short scale absolute value of a difference between a third value of the image data values in a first row or column of a subset of the register array and a fourth value of the image data values in the last row or column of the subset of the register array; and

generate the gradient value in response to a greatest absolute value of the long scale absolute value and the short scale absolute value.

19. A method for interpolating a color value at a target pixel in a digital image, the method comprising the steps of:

storing image data values for a portion of a digital image in a vicinity of a target pixel in a local array;

determining whether there is an edge in the vicinity of the target pixel based on the data values in the local array;

if there is not an edge in the vicinity of the target pixel, then performing long scale interpolation using image data values in the local array; and

if there is an edge in the vicinity of the target pixel, then performing short scale interpolation using image data values in a subset of the local array in a closer vicinity of the target pixel.

20. The method of claim 19, the step of determining whether there is an edge further comprising:

computing an first absolute value of a difference between a first data value at a first pixel in the local array and a second data value at a second pixel in the local array;

computing a gradient based on the absolute value; and

if the gradient exceeds a threshold value, then determining that there is an edge in the vicinity of the target pixel.

21. The method of claim 20, the computing the gradient further comprises the steps of:

computing a second absolute value of a difference between a third data value at a third pixel in the local array and a fourth data value at a fourth pixel in the local array; and

selecting as the gradient the larger of the first absolute value and the second absolute value.

22. The method of claim 21, wherein the first pixel is in a first column of the local array and the second pixel is in a last column of the local array; and the third pixel is in a first row of the local array and the fourth pixel is in a last row of the local array.

23. The method of claim 21, wherein the first pixel is in a first column of the local array and the second pixel is in a last column of the local array; and the third pixel is in a first column or row of the subset of the local array and the fourth pixel is in a last column or row of the subset of the local array.

24. The method of claim 20, wherein the data value of the first pixel and the data value of the last pixel are for the same color.

25. The method of claim 20, wherein the threshold is a certain percentage of a peak pixel value and the certain percentage is less than 100%.

26. The method of claim 25, wherein the certain percentage is in a range from about 5% to about 40%.

27. The method of claim 25, wherein the certain percentage is in a range from about 10% to about 20%.

28. The method of claim 20, wherein the step of computing a gradient further comprises computing a second absolute value of a difference between a third data value at a third pixel in the local array and a fourth data value at a fourth pixel in the local array; and selecting as the gradient a sum of the first absolute value and the second absolute value; and wherein the threshold is twice a certain percentage of a peak pixel value, and the certain percentage is less than 100%.

29. The method of claim 19, wherein the long scale interpolation is bicubic interpolation.

30. The method of claim 19, wherein the long scale interpolation is implemented as a weighted sum with weights that depend on the color for the image data at the target pixel and the color of the image data being interpolated to the target pixel.

31. The method of claim 30, wherein the weights are powers of two.

32. The method of claim 19, wherein the short scale interpolation is directed linear interpolation comprising the steps of discarding a greatest value and a least value of the image data values for a certain color being interpolated to the target pixel; and averaging the values of the remaining pixels.

33. The method of claim 32, wherein the number of remaining pixels is a power of two.

34. The method of claim 19, wherein the short scale interpolation is directed linear interpolation comprising the steps of selecting two pixels with values no farther apart than the values of any other pair of pixels for a certain color being interpolated to the target pixel; and averaging the values of the two pixels.

35. The method of claim 19, wherein the short scale interpolation is directed linear interpolation comprising the steps of discarding a certain pixel, if a location of the edge determined to be present lies between the certain pixel and the target pixel; and averaging the values of the remaining pixels.

36. A computer readable medium carrying one or more sequences of instructions for interpolating a color value at a target pixel in a digital image, which instructions, when executed by one or more processors, cause the one or more processors to carry out the steps of:

storing image data values for a portion of a digital image in a vicinity of a target pixel in a local array;

determining whether there is an edge in the vicinity of the target pixel based on the data values in the local array;

if there is not an edge in the vicinity of the target pixel, then performing long scale interpolation using image data values in the local array; and

if there is an edge in the vicinity of the target pixel, then performing short scale interpolation using image data values in a subset of the local array in a closer vicinity of the target pixel.

37. A carrier wave carrying one or more sequences of instructions for interpolating a color value at a target pixel in a digital image, which instructions, when executed by one or more processors, cause the one or more processors to carry out the steps of:

storing image data values for a portion of a digital image in a vicinity of a target pixel in a local array;

determining whether there is an edge in the vicinity of the target pixel based on the data values in the local array;

if there is not an edge in the vicinity of the target pixel, then performing long scale interpolation using image data values in the local array; and

if there is an edge in the vicinity of the target pixel, then performing short scale interpolation using image data values in a subset of the local array in a closer vicinity of the target pixel.

38. The method of claim 28, wherein the weights are short sums of powers of two.